INTEGRATED CIRCUITS

DATA SHEET

TDA1023/T

Proportional-control triac triggering circuit

Product specification
Supersedes data of August 1982
IC02

May 1991

Philips Semiconductors

PHILIPS

Proportional-control triac triggering circuit

TDA1023/T

FEATURES

- Adjustable width of proportional range
- Adjustable hysteresis
- Adjustable width of trigger pulse
- Adjustable repetition timing of firing burst
- Control range translation facility
- Fail safe operation
- Supplied from the mains
- Provides supply for external temperature bridge

APPLICATIONS

- Panel heaters
- Temperature control

GENERAL DESCRIPTION

The TDA1023 is a bipolar integrated circuit for controlling triacs in a proportional time or burst firing mode. Permitting precise temperature control of heating equipment it is especially suited to the control of panel heaters. It generates positive-going trigger pulses but complies with regulations regarding mains waveform distortion and RF interference.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage (derived from mains voltage)	-	13.7	-	V
V_Z	stabilized supply voltage for temperature bridge	-	8	-	V
$I_{16(AV)}$	supply current (average value)	-	10	-	mA
t_w	trigger pulse width	-	200	-	µs
T_b	firing burst repetition time at C_T = 68 µF	-	41	-	s
$-I_{OH}$*	output current	-	-	150	mA
T_{amb}	operating ambient temperature range	−20	-	+75	°C

Note

*Negative current is defined as conventional current flow out of a device. A negative output current is suited for positive triac triggering.

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TDA1023	16	DIL	plastic	SOT38
TDA1023T	16	mini-pack	plastic	SO16; SOT109A

Proportional-control triac triggering circuit

TDA1023/T

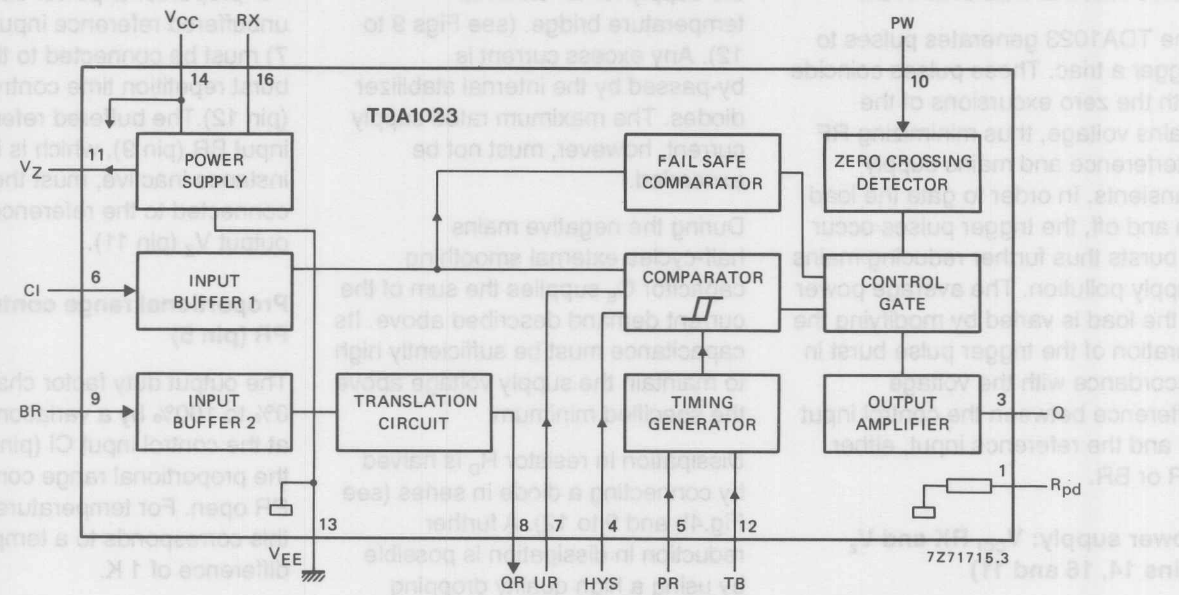


Fig.1 Block diagram.

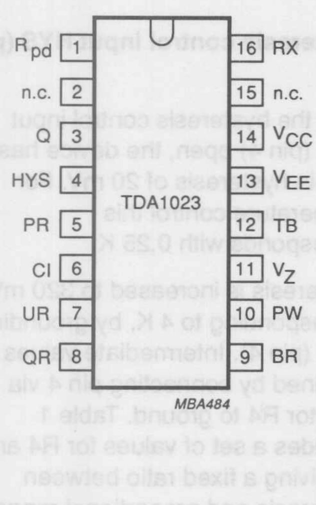


Fig.2 Pin configuration.

PINNING

SYMBOL	PIN	DESCRIPTION
R_{pd}	1	internal pull-down resistor
n.c.	2	not connected
Q	3	output
HYS	4	hysteresis control input
PR	5	proportional range control input
CI	6	control input
UR	7	unbuffered reference input
QR	8	output of reference buffer
BR	9	buffered reference input
PW	10	pulse width control input
V_Z	11	reference supply output
TB	12	firing burst repetition time control input
V_{EE}	13	ground
V_{CC}	14	positive supply
n.c.	15	not connected
RX	16	external resistor connection

FUNCTIONAL DESCRIPTION

The TDA1023 generates pulses to trigger a triac. These pulses coincide with the zero excursions of the mains voltage, thus minimizing RF interference and mains supply transients. In order to gate the load on and off, the trigger pulses occur in bursts thus further reducing mains supply pollution. The average power in the load is varied by modifying the duration of the trigger pulse burst in accordance with the voltage difference between the control input CI and the reference input, either UR or BR.

Power supply: V_{CC}, RX and V_z (pins 14, 16 and 11)

The TDA1023 is supplied from the AC mains via a resistor R_D to the RX connection (pin 16); the V_{EE} connection (pin 13) is linked to the neutral line (see Fig.4a). A smoothing capacitor C_S should be coupled between the V_{CC} and V_{EE} connections.

A rectifier diode is included between the RX and V_{CC} connections whilst the DC supply voltage is limited by a chain of stabilizer diodes between the RX and V_{EE} connections (see Fig.3).

A stabilized reference voltage (V_Z) is available at pin 11 to power an external temperature sensing bridge.

Supply operation

During the positive mains half-cycles the current through the external voltage dropping resistor R_D charges the external smoothing capacitor C_S until RX attains the stabilizing potential of the internal stabilizing diodes. R_D should be selected to be capable of supplying the current I_{CC} for the TDA1023, the average output current $I_{3(AV)}$, recharge the smoothing capacitor C_S and provide the supply for an external temperature bridge. (see Figs 9 to 12). Any excess current is by-passed by the internal stabilizer diodes. The maximum rated supply current, however, must not be exceeded.

During the negative mains half-cycles external smoothing capacitor C_S supplies the sum of the current demand described above. Its capacitance must be sufficiently high to maintain the supply voltage above the specified minimum.

Dissipation in resistor R_D is halved by connecting a diode in series (see Fig.4b and 9 to 12). A further reduction in dissipation is possible by using a high quality dropping capacitor C_D in series with a resistor R_{SD} (see Figs 4c and 14). Protection of the TDA1023 and the triac against mains-borne transients can be provided by connecting a suitable VDR across the mains input.

Control and reference inputs CI, BR and UR (pins 6, 9 and 7)

For the control of room temperature (5 °C to 30 °C) optimum performance is obtained by using the translation circuit. The buffered reference input BR (pin 9) is used as a reference input whilst the output reference buffer QR (pin 8) is connected to the unbuffered reference input UR (pin 7). This ensures that the range of room temperature is encompassed in most of the rotation of the potentiometer to give a linear temperature scale with accurate setting.

Should the translation circuit not be required, the unbuffered reference input UR (pin 7) is used as a reference input. The buffered reference input BR (pin 9) must then be connected to the reference supply output V_Z (pin 11).

For proportional power control the unbuffered reference input UR (pin 7) must be connected to the firing burst repetition time control input TB (pin 12).The buffered reference input BR (pin 9), which is in this instance inactive, must then be connected to the reference supply output V_Z (pin 11).

Proportional range control input PR (pin 5)

The output duty factor changes from 0% to 100% by a variation of 80 mV at the control input CI (pin 6) with the proportional range control input PR open. For temperature control this corresponds to a temperature difference of 1 K.

By connecting the proportional range control input PR (pin 5) to ground the range may be increased to 400 mV, i.e. 5 K. Intermediate values may be obtained by connecting the PR input to ground via a resistor R5 (see Table 1).

Hysteresis control input HYS (pin 4)

With the hysteresis control input HYS (pin 4) open, the device has a built-in hysteresis of 20 mV. For temperature control this corresponds with 0.25 K.

Hysteresis is increased to 320 mV, corresponding to 4 K, by grounding HYS (pin 4). Intermediate values are obtained by connecting pin 4 via resistor R4 to ground. Table 1 provides a set of values for R4 and R5 giving a fixed ratio between hysteresis and proportional range.

Trigger pulse width control input PW (pin 10)

The width of the trigger pulse may be adjusted to the value required for the triac by choosing the value of the external synchronization resistor

R_S between the trigger pulse width control input PW (pin 10) and the AC mains. The pulse width is inversely proportional to the input current (see Fig.13).

Output Q (pin 3)

Since the circuit has an open-emitter output it is capable of sourcing current. It is thus suited for generating positive-going trigger pulses. The output is current-limited and short-circuit protected. The maximum output current is 150 mA and the output pulses are stabilized at 10 V for output currents up to that value.

To minimize the total supply current and power dissipation, a gate resistor R_G must be connected between the output Q and the triac gate to limit the output current to the minimum required by the triac (see Figs 5 to 8).

Pull-down resistor R_{pd} (pin 1)

The TDA1023 includes a 1.75 kΩ pull-down resistor R_{pd} between pins 1 and 13 (V_{EE}, ground connection) intended for use with sensitive triacs.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	DC supply voltage	-	16	V
Supply current				
$I_{16(AV)}$	average	-	30	mA
$I_{16(RM)}$	repetitive peak	-	100	mA
$I_{16(SM)}$	non-repetitive peak (tp < 50 µs)	-	2	A
V_I	input voltage, all inputs	-	16	V
$I_{6, 7, 9, 10}$	input current	-	10	mA
V_1	voltage on R_{pd} connection	-	16	V
$V_{3, 8, 11}$	output voltage, Q, QR, V_Z	-	16	V
Output current				
$-I_{OH(AV)}$	average	-	30	mA
$-I_{OH(M)}$	peak max. 300 µs	-	700	mA
P_{tot}	total power dissipation	-	500	mW
T_{stg}	storage temperature range	−55	+150	°C
T_{amb}	operating ambient temperature range	−20	+75	°C

CHARACTERISTICS

V_{CC} = 11 to 16 V; T_{amb} = −20 to +75 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply						
V_{CC}	internally stabilized supply voltage at I_{16} = 10mA		12	13.7	15	V
$\Delta V_{CC}/\Delta I_{16}$	variation with I_{16}		-	30		mV/mA
I_{16}	supply current at $V_{16\text{-}13}$ = 11 to 16 V I_{10} = 1mA; f = 50 Hz; pin 11 open; $V_{6\text{-}13} > V_{7\text{-}13}$	pins 4 and 5 open	-	-	6	mA
		pins 4 and 5 grounded	-	-	7.1	mA
Reference supply output V_Z (pin 11) for external temperature bridge						
$V_{11\text{-}13}$	output voltage		-	8	-	V
$-I_{11}$	output current		-	-	1	mA
Control and reference inputs CI, BR and UR (pins 6, 9 and 7)						
$V_{6\text{-}13}$	input voltage to inhibit the output		-	7.6	-	V
$I_{6,7,9}$	input current	V_1 = 4 V	-	-	2	μA
Hysteresis control input HYS (pin 4)						
ΔV_6	hysteresis	pin 4 open	9	20	40	mV
ΔV_6	hysteresis	pin 4 grounded	-	320	-	mV
Proportional control range input PR (pin 5)						
ΔV_6	proportional range	pin 5 open	50	80	130	mV
ΔV_6	proportional range	pin 5 grounded	-	400		mV
Pulse width control input PW (pin 10)						
t_w	pulse width	$I_{10(RMS)}$ = 1mA; f = 50 Hz	100	200	300	μs
Firing burst repetition time control input TB (pin 12)						
$T_b C_T$	firing burst repetition time, ratio to capacitor C_T		320	600	960	ms/μF
Output of reference buffer QR (pin 8)						
	output voltage at input voltage:					
$V_{8\text{-}13}$		$V_{9\text{-}13}$ = 1.6 V	-	3.2	-	V
$V_{8\text{-}13}$		$V_{9\text{-}13}$ = 4.8 V	-	4.8	-	V
$V_{8\text{-}13}$		$V_{9\text{-}13}$ = 8 V	-	6.4	-	V
Output Q (pin 3)						
V_{OH}	output voltage HIGH	$-I_{OH}$ = 150 mA	10	-	-	V
$-I_{OH}$	output current HIGH		-	-	150	mA
Internal pull-down resistor R_{pd} (pin 1)						
R_{pd}	resistance to V_{EE}		1	1.75	3	kΩ

Table 1 Adjustment of proportional range and hysteresis. Combinations of resistor values giving hysteresis > $^1/_4$ proportional range.

Proportional range mV	Proportional range resistor R5 kΩ	Minimum hysteresis mV	Maximum hysteresis resistor R4 kΩ
80	open	20	open
160	3.3	40	9.1
240	1.1	60	4.3
320	0.43	80	2.7
400	0	100	1.8

Table 2 Timing capacitor values C_T

Effective DC value	Marked AC specification		Catalogue number*
µF	µF	V	
68	47	25	2222 016 90129
47	33	40	- - 90131
33	22	25	- 015 90102
22	15	40	- - 90101
15	10	25	- - 90099
10	6.8	40	- - 90098

Note

*Special electrolytic capacitors recommended for use with the TDA1023.

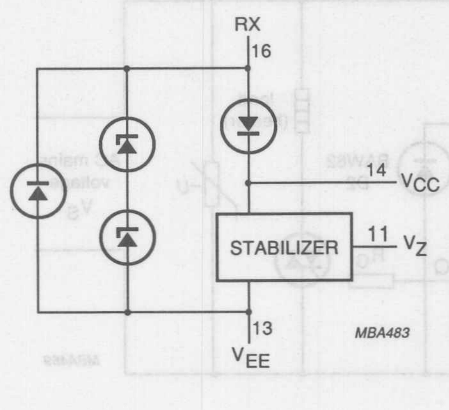


Fig.3 Internal supply connections.

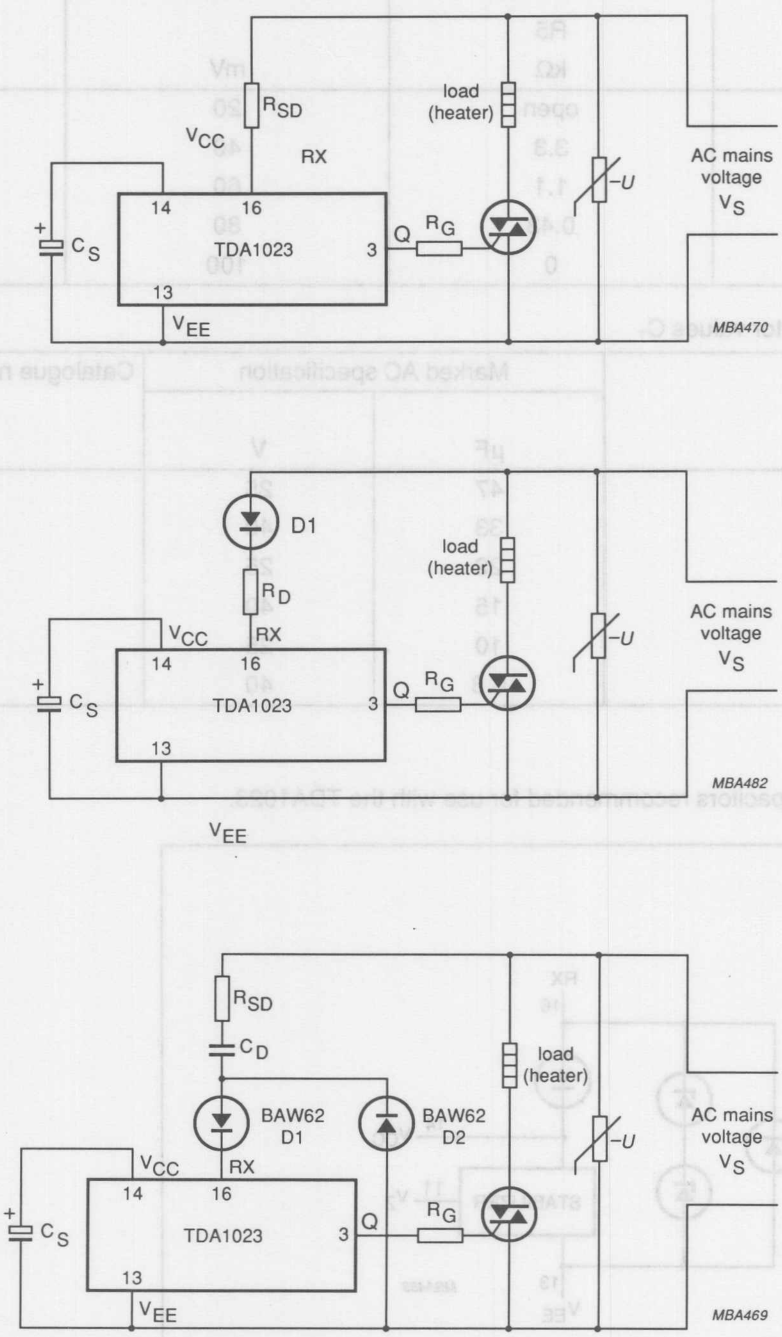


Fig.4 Alternative supply arrangements.

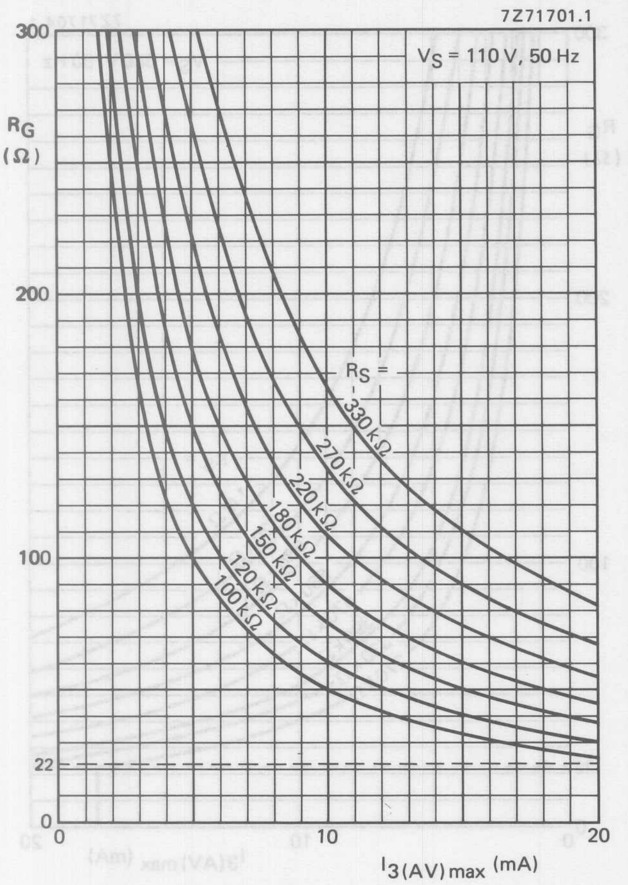


Fig.5 V_S = 110 V, 50 Hz.

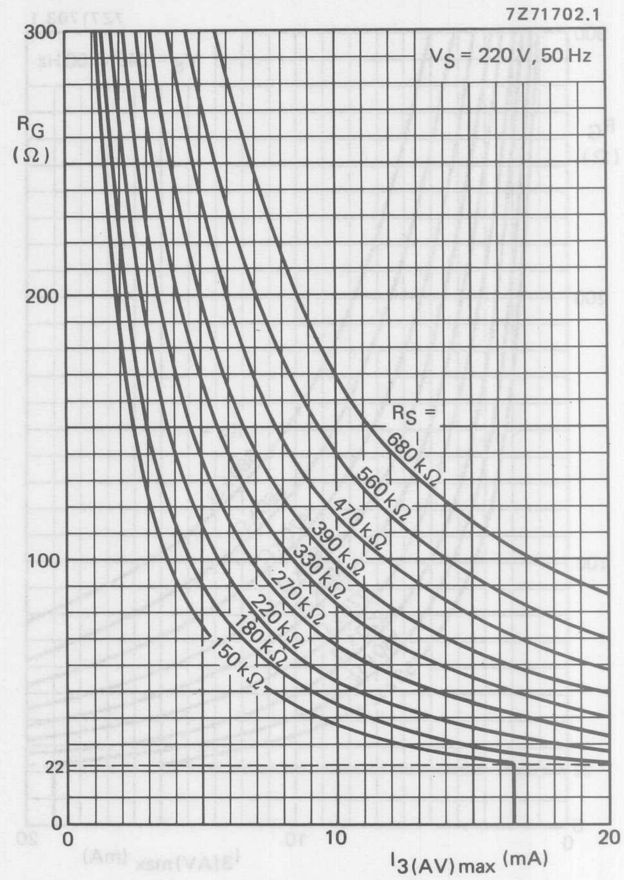


Fig.6 V_S = 220 V, 50 Hz.

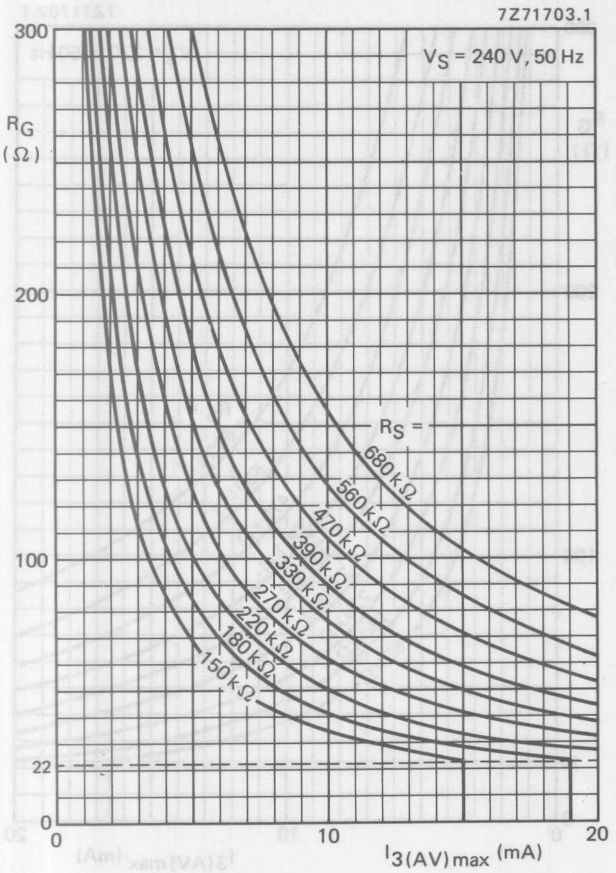


Fig.7 V_s = 240 V, 50Hz.

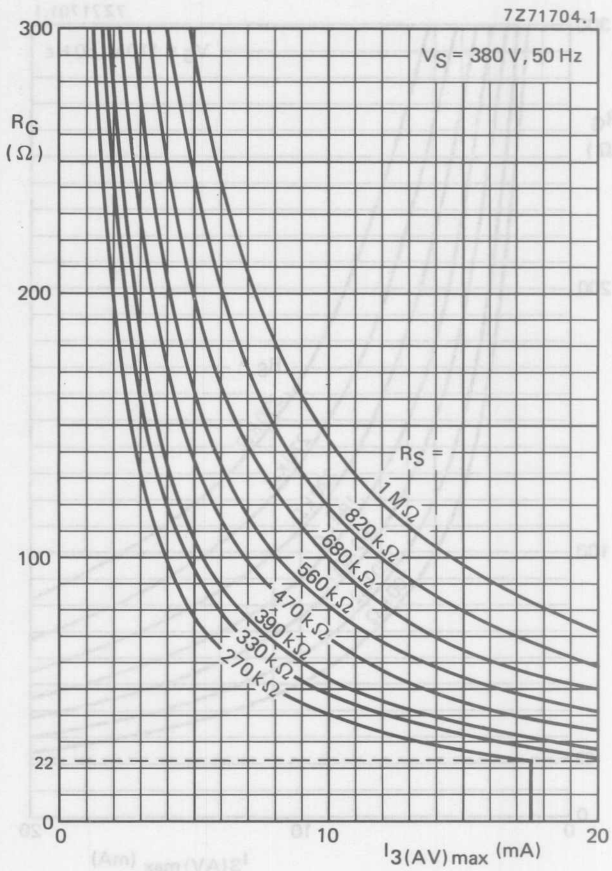


Fig.8 V_s = 380 V, 50 Hz.

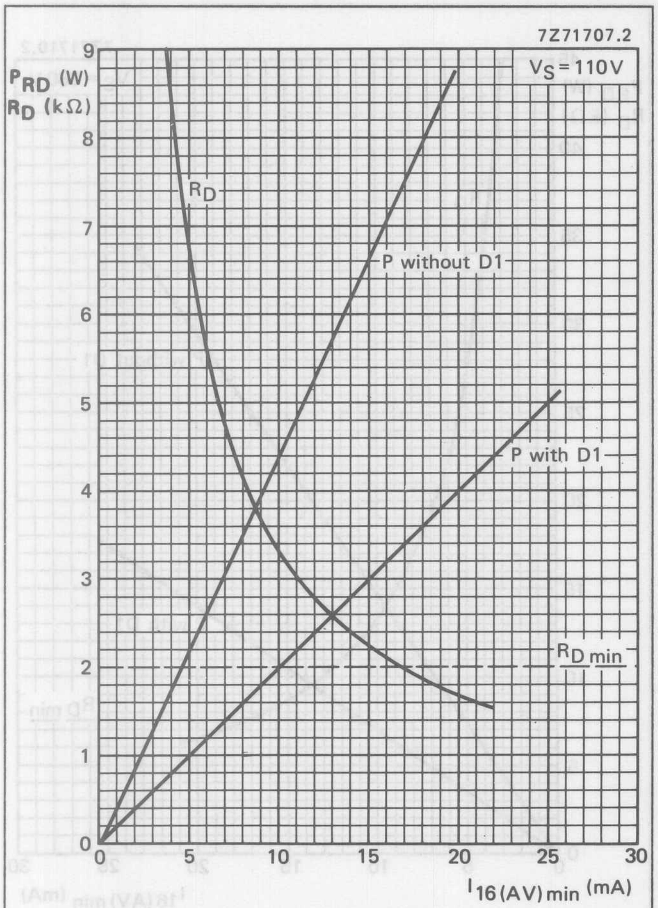


Fig.9 V_s = 110 V.

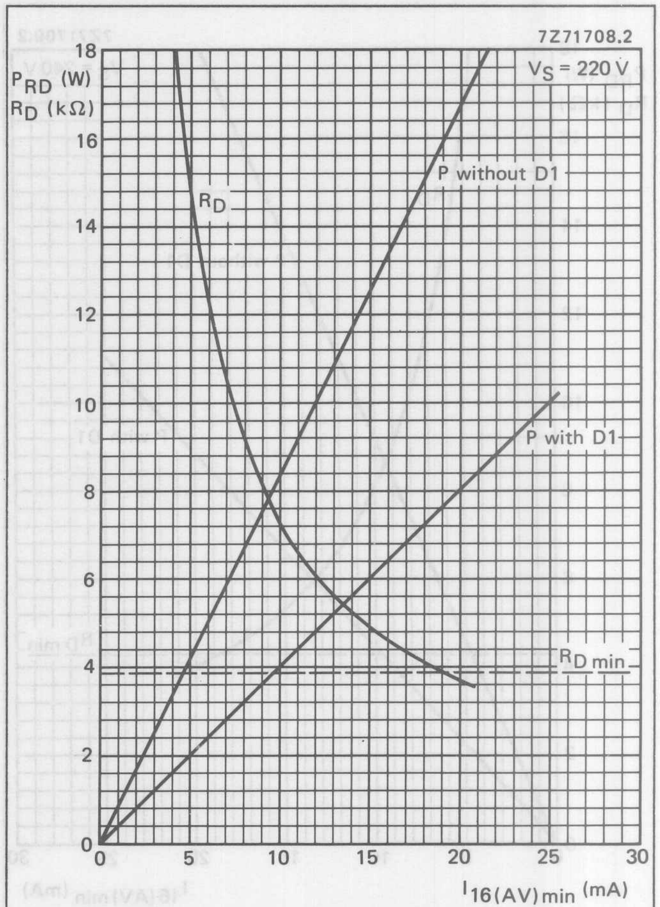


Fig.10 V_s = 220 V.

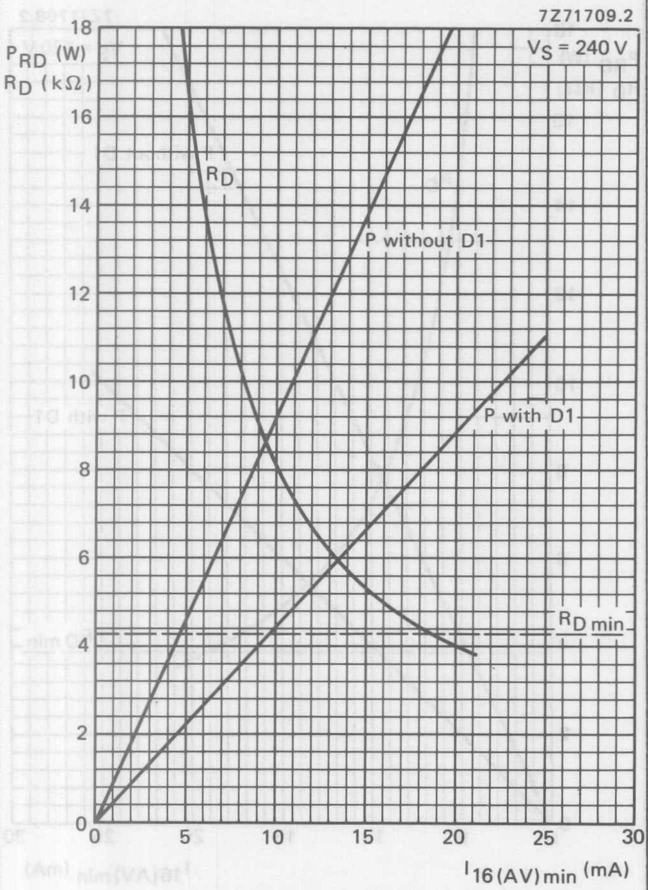


Fig.11 V_S = 240 V.

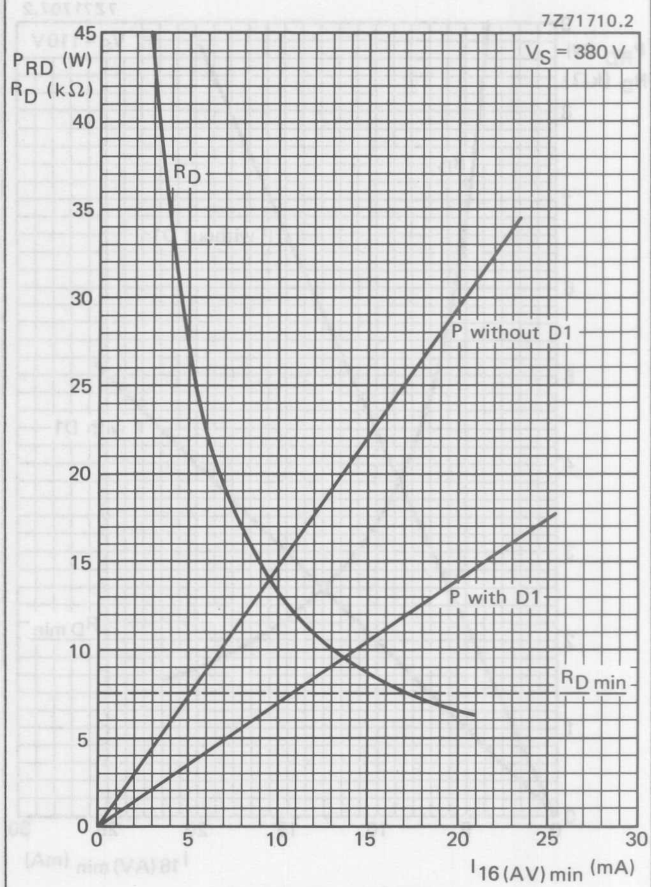
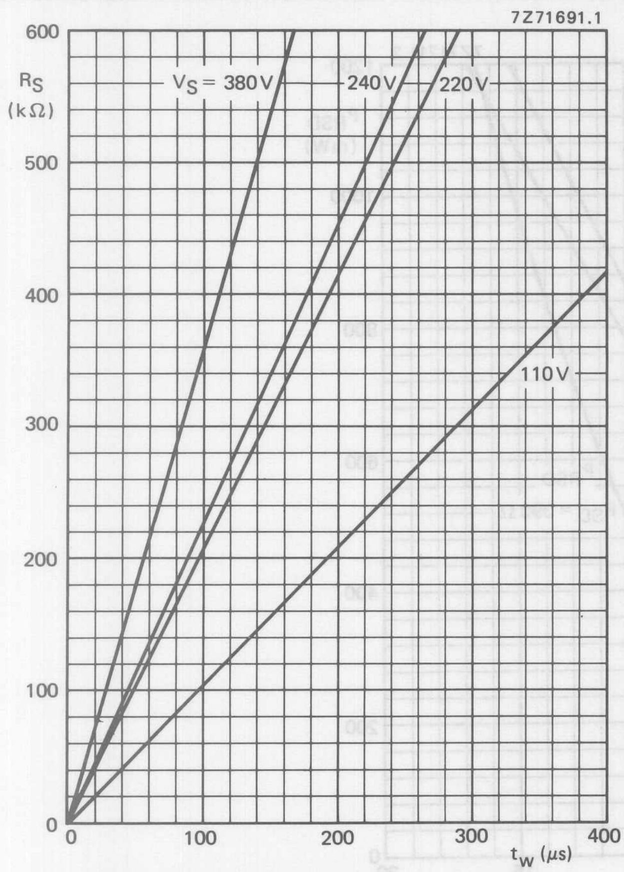


Fig.12 V_S = 380 V.



of required trigger pulse width t_w with a mains voltage V_S as a parameter.

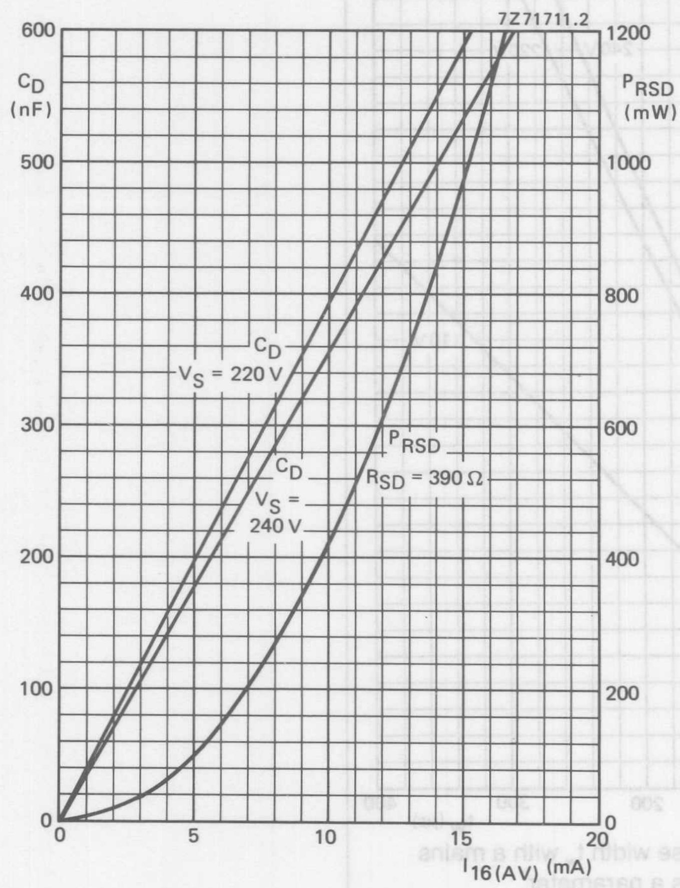
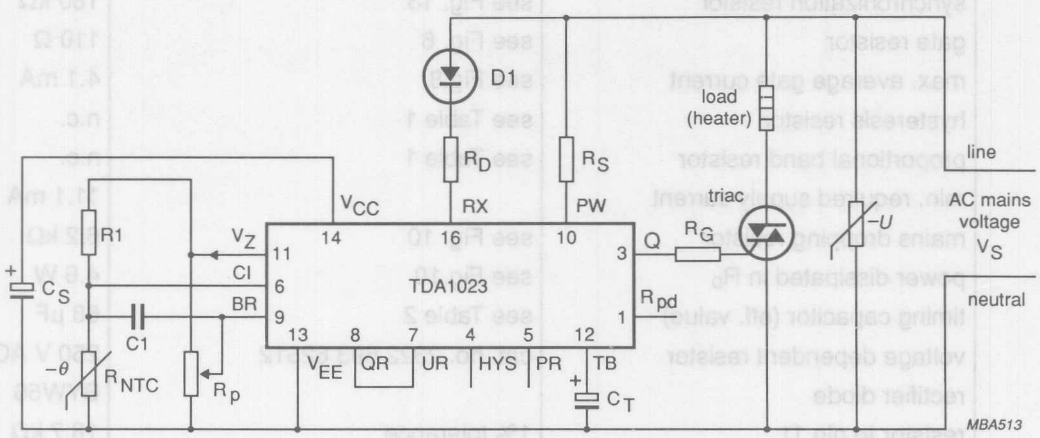


Fig.14 Nominal value of voltage dropping capacitor C_D and power P_{RSD} dissipated in a voltage dropping resistor R_{SD} as a function of average supply current $I_{16\ (AV)}$ with the mains supply voltage V_S as a parameter.



Conditions:- Mains supply; V_S = 220 V; Temperature range = 5 to 30 °C.
BT139 data at T_j = 25 °C; V_{gt} < 1.5 V; I_{gt} > 70 mA; I_L < 60 mA

Fig.15 The TDA1023/T used in a 1200 to 2000 W heater with triac BT139. For component values see Table 3.

Table 3 Temperature controller component values (see Fig. 15).

SYMBOL	PARAMETER	REMARKS	VALUE
t_w	trigger pulse width	see BT139 data sheet	75 µs
R_S	synchronization resistor	see Fig. 13	180 kΩ
R_G	gate resistor	see Fig. 6	110 Ω
$I_{3(AV)}$	max. average gate current	see Fig.8	4.1 mA
R4	hysteresis resistor	see Table 1	n.c.
R5	proportional band resistor	see Table 1	n.c.
$I_{16(AV)}$	min. required supply current		11.1 mA
R_D	mains dropping resistor	see Fig. 10	6.2 kΩ
P_{RD}	power dissipated in R_D	see Fig.10	4.6 W
C_T	timing capacitor (eff. value)	see Table 2	68 µF
VDR	voltage dependent resistor	cat. no. 2322 593 62512	250 V AC
D1	rectifier diode		BYW56
R1	resistor to pin 11	1% tolerance	18.7 kΩ
R_{NTC}	NTC thermistor (at 25 °C)	B = 4200 K cat no. 2322 642 12223	22 kΩ
R_p	potentiometer		22 kΩ
C1	capacitor between pins 6 and 9		47 nF
C_S	smoothing capacitor		220 µF; 16 V
If R_D and D1 are replaced by C_D and R_{SD}			
C_D	mains dropping capacitor		470 nF
R_{SD}	series dropping resistor		390 Ω
P_{RSD}	power dissipated in R_{SD}	see Fig.14	0.6 W
VDR	voltage dependent resistor	cat. no. 2322 594 62512	250 V AC

Notes

1. ON/OFF control: pin 12 connected to pin 13.
2. If translation circuit is not required: slider of R_p to pin 7; pin 8 open; pin 9 connected to pin 11.

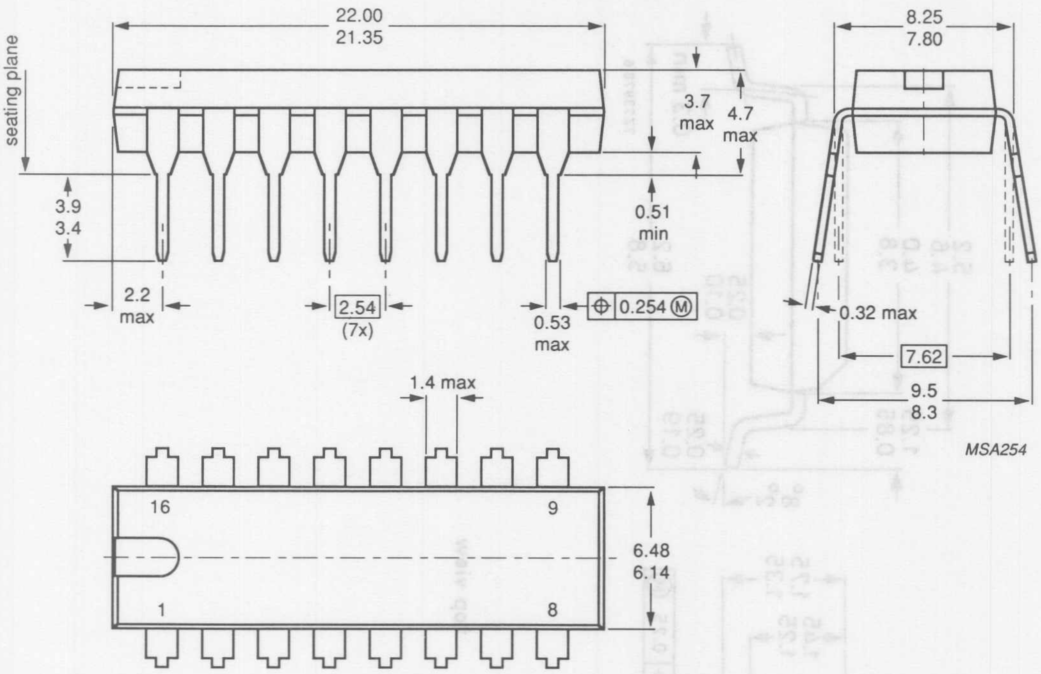


Fig.16 16-lead dual in-line; plastic (SOT38).

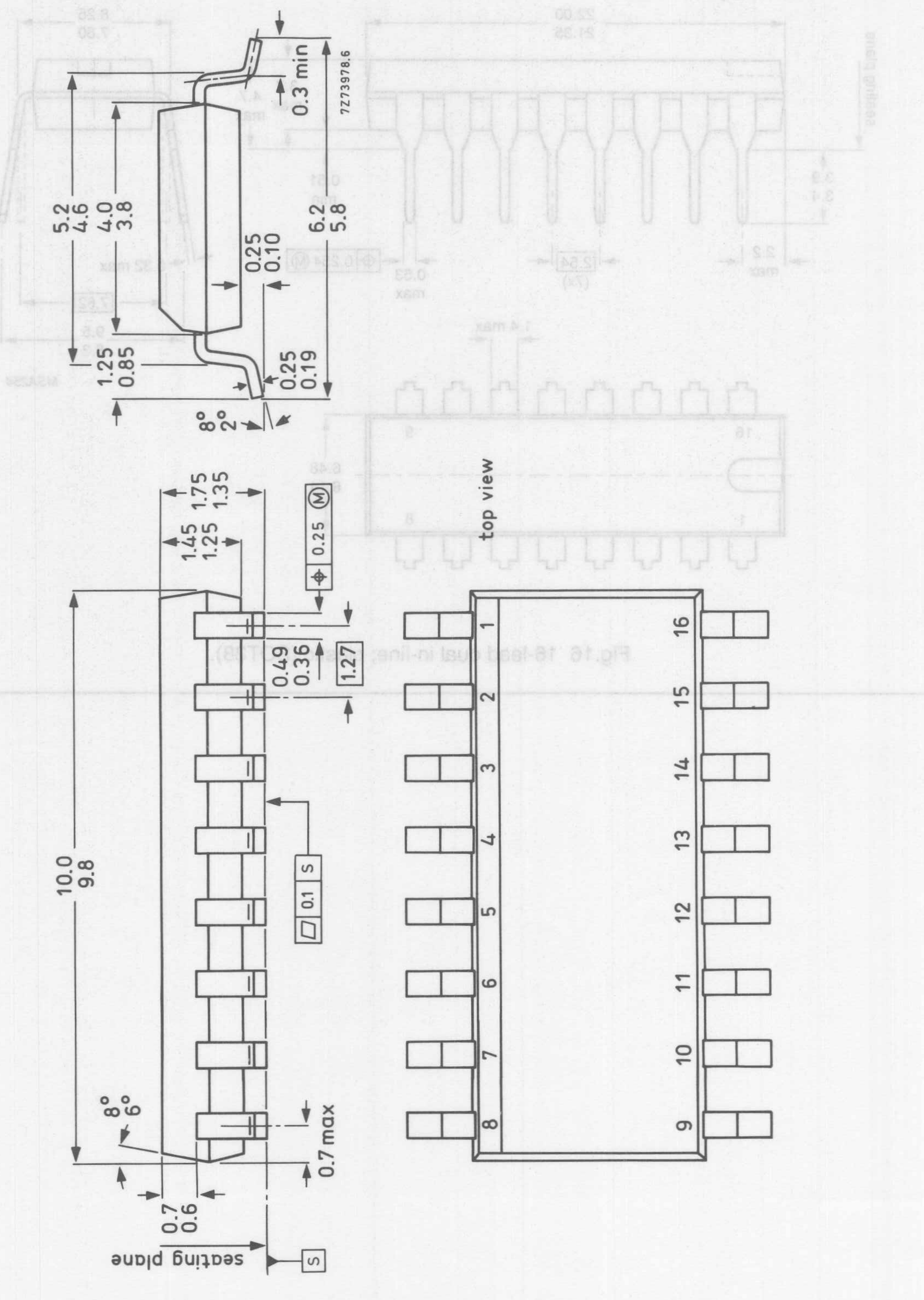


Fig.17 16-lead mini-pack; plastic (SO16; SOT109A)

SOLDERING

Plastic dual-in line packages

BY DIP OR WAVE

The maximum permissible temperature of the solder is 260 °C. This temperature must not be in contact with the joint for more than 5 s. The total contact time of successive solder waves must not exceed 5 s.

The device may be mounted up to the seating plane but the temperature of the plastic body must not exceed the specified storage maximum. If the printed-circuit board has been preheated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

REPAIRING SOLDERED JOINTS (BY HAND)

Apply the soldering iron below the seating plane (or not more than 2 mm above it). If its temperature is below 300 °C it must not be in contact for more than 10 s; if between 300 and 400 °C, for not more than 5 s.

Plastic mini-packs

BY WAVE

During placement and before soldering, the component must be fixed with a droplet of adhesive. After curing the adhesive, the component can be soldered. The adhesive can be applied by screen printing, pin transfer or syringe dispensing.

Maximum permissible solder temperature is 260 °C and maximum duration of package immersion in solder bath is 10 s, if allowed to cool to less than 150 °C within 6 s. Typical dwell time is 4 s at 250 °C.

A modified wave soldering technique is recommended using two solder waves (dual wave) in which a turbulent wave with high upward pressure is followed by a smooth laminar wave. Using a mildly-activated flux eliminates the need for removal of corrosive residues in most applications.

BY SOLDER PASTE REFLOW

Reflow soldering requires the solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the substrate by screen printing, stencilling or pressure-syringe dispensing before device placement.

Several techniques exist for reflowing; for example, thermal conduction by heated belt, infrared, and vapour-phase reflow. Dwell times vary between 50 and 300 s according to method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 min at 45 °C.

REPAIRING SOLDERED JOINTS (BY HAND-HELD SOLDERING IRON OR PULSE-HEATED SOLDER TOOL)

Fix the component by first soldering two, diagonally opposite, end pins. Apply the heating tool to the flat part of the pin only. Contact time must be limited to 10 s at up to 300 ° C. When using proper tools, all other pins can be soldered in one operation within 2 to 5 s at between 270 and 320 °C. (Pulse-heated soldering is not recommended for SO packages).

For pulse-heated solder tool (resistance) soldering of VSO packages, solder is applied to the substrate by dipping or by an extra thick tin/lead plating before package placement.

CLEANING

Avoid cleaning if possible.

If cleaning is necessary use cold or hot water. A detergent may be added to the water. Finally rinse with de-ionized water.

Do **not** use ultrasonic cleaning methods as these may damage the inner or outer leads.

Do **not** use solvents.

Proportional-control triac triggering circuit

TDA1023/T

DEFINITIONS

Data sheet status	
Objective specification	This data sheet containstarget or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	

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